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SPECIFICATION  
MOTOR MANAGEMENT PROGRAM

TECHNICAL FIELD

The present invention relates generally to a modular system of providing motor management services, for example, to industrial plants and facilities.

BACKGROUND ART

Motor management services are performed at manufacturing plants and other types of plants and business facilities by employees of the business or by outside service providers.

According to the current state of the art, the case is such that in the majority of instances the customer pays for the provided services to the plant by the service provider according to time and expense. The individual motor-related services are performed on the basis of specific contracts; i.e. motors are replaced, motor status analyses are carried out, motors are rewound, etc., when the customer considers it necessary or following some corresponding guidelines. Up to now, the providing of motor services has all been a transactional relationship.

Among the motor services provided according to the known art are emergency services, usually with appointment of personnel to perform the service, and motor repair/replacement services. The motor repair/replacement service partly ensues with warehoused parts of the service provider.

The above-described prior art is not what is best for the customer. The customer needs a technologically and organizationally better solution.

As global competition increases and supply chains become shorter, businesses are being forced to find new ways to increase plant performance while simultaneously reducing costs. Complexity of the business adds to the costs, and one area of significant complexity for manufacturing businesses is plant maintenance, such as of

the motors in the plant. In addition to adding complexity, motor maintenance can add to the total costs of production. While motor maintenance is critical to the business outcome, it is often regarded as a necessary evil, and as a result it has been difficult to achieve sustained improvement in performance from an in-house maintenance group without intense management effort that detracts from the core business process and the core competency.

#### DISCLOSURE OF THE INVENTION

An object of the invention is to provide a better solution for providing motor services to a customer, particularly to enhance the customer's financial system result (the profit of the customer) and to lower the costs over the life time of the system (life time costs). For this purpose, the availability and the reliability of the motor system -- in the form of availability time windows on demand -- are adapted to the demand of the production processes, of the market, etc. The present invention makes an optimum solution of the customer motor service needs possible, i.e. a solution matched to the customer business demands.

A further object is to provide increased motor reliability and availability, reduced costs through a proactive Business Based Maintenance approach, minimized motor downtime, optimized asset management, capital solutions, and fast response when and where it is needed.

Another object of the present invention is to provide modular standardized services for motor management. A customer is offered modular services and free to select those motor services that meet the customer's needs.

A further object of the invention is to provides motor services at two levels, a basic level and a high end options level. Examples of high end options include business oriented motor services, financing, full coverage for motor repair and replacement, etc.

In the present system, a customer desiring maintenance services is provided a menu of available motor services from which to select desired motor services

modules. A uniform service architecture is provided. Modules are provided at various business levels, from the general to the specific. In one embodiment, two levels are provided. Examples of the two levels include a business-oriented level that is offered as an option and a technology-oriented level that is offered as basic modules.

The present motor management program has been developed based on the view of motors and motor servicing by many businesses. Motors are viewed by many businesses as a commodity item, and the present motor management program provides and services the motors and provides various aspect of motor maintenance for this "commodity". A further reason for addressing motors specifically in the present invention is that many businesses see motors as a hand-through, or pass-through, portion of their business that historically may have some aspects provided by outside suppliers. It is easier to convince the business operator to change to the present modular outsourced services for motors than for some aspect of maintenance that has traditionally been performed by the business only in-house. A further advantage is that the business may neither have the expertise nor interest in optimizing the motor aspects of their plants. The present invention provides such expertise as a service and addresses it from a business-oriented approach with a view to the bottom line of the plant.

The motor maintenance services offered also fall into the broad areas of technical services relating to motors, such as: consulting, repair service, motor supply, etc. The customer needs are evaluated using a business review and interview process and the customer is offered the services which are found to meet the customer's needs as revealed in the business review as modules selected from a menu. The modules, which are implemented through software modules and hardware as well as motor maintenance processes and procedures, are installed at a local level in each plant. However, operation and control of the service is provided through regional facilities that are linked to the local facilities by a communication connection, such as through

the Internet or via a dedicated phone line or private network. The regional facilities are provided at regions around the globe so as to offer 24-hour support to the local service locations, including providing a regional center in the Far East, one in the European Union, and one in a NAFTA country. One of these regional centers are open during business hours at any time of the day to provide support for the local service locations. The regional centers are in turn connected via communication links to a single world-wide headquarters.

Electronic system plans are employed, potentially based on standard organization software like CMMS (Computerized Maintenance Management Systems), CAD data, electronic handbooks, and Excel lists. This software is respectively employed at a location of a specific customer or can be provided over the Internet. The individual programs run on a standard operating system platform; they are implemented either in the computer system of the customer system or on servers of the respective provider center, for instance a Customer Service Center. However, monitoring by the respective Customer Service Center is always a feature, this center being in charge in a country or international regions as well, for example USA and Canada. Communication via the Internet with special measures for secure transmission is provided.

The present invention provides outsourced motor maintenance as a part of a business strategy. The outsourced motor is provided for all motors in a plants or a defined scope of motors in a plant. According to the present invention, plants are defined broadly to include airports, steel mills, hospitals, mines, ship yards, large buildings, hotels, chemical plants, cement plants, subway systems, railway systems, container terminals, oil drilling rigs or platforms, paper mills, oil or natural gas pipeline systems, lime plants, water treatment plants including desalination, fresh water pipelining and waste water treatment, food service facilities, etc.

The motor maintenance services offered also fall into the broad areas of technical services, consulting, repair service, parts supply, etc. The customer needs

are evaluated and the customer is offered the services as modules selected from a menu.

Decisions on motor maintenance services are divided between the global, regional or local level. Business strategies for the customer, choices of modules to use, etc. are preferably made on the global level. Regional level decisions are determined by regional laws and regulations, manpower availability, etc. The local level is the plant level wherein decisions at that level are specific to the needs of that plant.

Within the context of the present application, motor maintenance services refers to and includes all those services described herein.

The invention addresses the challenges being put to companies by reducing complexity, thereby enabling greater focus on the core business. One area of significant complexity for manufacturing businesses is plant maintenance.

The present invention delivers business-based professional motor maintenance services on a modular basis throughout the world. The present invention utilizes vast worldwide technical expertise and presence to provide the business-based maintenance, for example, by focusing on business aspects such as return on assets, return on investments, and motor availability for producing output.

Businesses face increases in productivity demands and international competition while striving to keep up with technical developments. The present invention provides outsourcing of motor maintenance processes as a cost effective and asset effective strategy. The outsourced motor services cover maintenance during the operational phase and include the modernizations.

As a further service, on-call and logistic services provide dependable requirement- oriented fault elimination for motors. Field service staff is available at the plant and repair services carry out necessary repair work at repair centers while on-line service centers communicate directly with the technical plants. Logistics services ensures that the correct motor parts are provided.

Thus, the present invention provides commercially focused strategies and takes on more performance based relationships with customers that include accepting more calculated risk in a win-win partnership approach.

The present invention is part of a broader concept of providing a broad range of technical services to plants, this being described in more detail in a PCT patent application for Technical Services Program, docket number P00,1821, filed by the applicant of the present application, the content thereof being incorporated herein by reference. An overall concept of providing outsourced services is disclosed in a PCT patent application entitle Plant Maintenance Technology Architecture docket number P00,1823, filed by the applicant of the present application, the content thereof being incorporated herein by reference. A generally related patent application is a Menu Driven Management and Operation Technique, docket number P00,1824, filed by the applicant of the present application, the content thereof being incorporated herein by reference.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a process flow of steps to implementation of outsourced motor maintenance according to the present invention;

Figure 2 is a schematic diagram of a design model for the present invention;

Figure 3 is a schematic diagram showing the menu of motor services available under the present invention;

Figure 4 is a block diagram showing implementation of the motor services;

Figure 5 is a diagram of the involvement of the present invention in the life cycle of plant; and

Figure 6 a diagram showing alignment of the customer's goals and the motor service provider's goals according to the present invention.

#### MODES FOR CARRYING OUT THE INVENTION

Referring first to **Figure 1**, a process for offering motor services to a customer is shown, including first a pre-screening 10 at the first contact with the customer. Included in this pre-screening is a first contact questionnaire to the prospective customer and discovery of information about the prospective customer via the Internet, and other sources.

In a second step, customer needs are discussed 12, which covers finding out what the customer needs, answering a questionnaire directed to the motor services program, which is done through several meetings. A letter of intent 14 is prepared to establish a consensus to consider the motor services program. These first three steps in the process provide tests of the customer's commitment to proceed.

The next step is to determine the needs and priorities 16 of the customer. Priority areas for improvement are identified. As a tool to identify these, a motor management review having, in one embodiment, 9 aspect areas, might be performed using a questionnaire. Topic areas are set forth for example in tabular format and the questioner observes and asks questions to determine the answers to the questions. The questions are also divided into five levels to identify a sophistication level of the prospective customer's technical and motor maintenance services, systems and procedures.

As a further step 18, a motor management program proposal is prepared and presented to the prospective customer. This is done with reference to the menu of modular services and options, which will be discussed later. This menu is also referred to as a program structure. As an important part of the proposal 18, the goals of the business are considered, an implementation plan is developed, a contract structure is determined, a return on investment is studied, and key performance indicators are identified.

These same aspects are considered during the negotiation and execution of the contract 20. Once the contract is made, the outsourced motor services are implemented at 22. A business based maintenance or BBM analysis is performed.

An motor condition assessment is performed. Motor conditions are assessed, and a CIP is implemented. The implementation 22 of the motor services program also utilizes a menu of services.

A design model is shown in **Figure 2** for the present motor management program. At first a customer may be unaware of opportunities for improvement at 30. During the motor management review 32, the customer recognizes the opportunities 34 and prioritizes the areas for improvement at 36. As a first phase 38 the condition assessment 40 is performed by gathering information 42. A feasibility study is conducted at 44 and a customized solution 46 is proposed to the customer. Implementation 48 of the service often yields information that can be used for improvement and so these aspect are fed back to modify the customized solution in a continuous improvement process 50.

In a second phase 52, a reliability verification 54 is performed by gathering information 56. A feasibility study 58 is conducted that leads to a customized solution 60. As before, when the solution is implemented at 62, ways to improve the process are discovered and these are fed back to the solution in a continuous improvement process 64.

Virtually all of a customer's motors will fall serviceable under the present motor management program. The customer has certain core competencies relating to its core business that these should be left to the customer to address. However, the various technical aspects of motor maintenance that play a supporting roll in the plant's production may each be addressed by the present invention by selection of modules from the menu of **Figure 3**.

**Figure 3** illustrates the modular services offered according to the motor management program of the present invention. These modular services are provided as a menu of services.

The upper portion of the menu sets forth the basic modules of the motor services. These are divided into five aspects, including on-site motor services 80,



support services 82, inventory management services 84, consulting and engineering services 86, and information management 88. The on-site service modules 80 include condition monitoring 90, 24-hour emergency response service 92, and preventative and corrective maintenance 96. Under support services 82 are provided overhaul and repair and rewind services 98, motor upgrades 100 and replacement motor supply 102.

The inventory management services 84 provide modules for inventory optimization and reduction 106, inventory reliability verification 108, storage and maintenance 110, and a shared inventory module 112. The consulting and engineering services 86 application engineering 114, reliability improvement 116, motor condition assessment 118, and a motor management review 120. The class of modules relating to information management 88 provide a system design and interface module 122 and a data management module 124.

Not only are there basic service modules but the present invention also provide high-end modules as shown at the lower portion of Figure 3. The first such high end module is a performance contracting module 130. This is followed by a capital improvement module 132, a full coverage module 134 and an energy optimization module 136.

The outsourced motor service provider and/or the customer looks to these menus to discover modules that best fit the customer's needs. For example, the customer may choose a storage and maintenance module 110 and the 24 hour emergency response module 92 along with other modules.

Once the modules are chosen they are implemented, for example, as shown in Figure 4. The implementation begins with the development of a maintenance strategy 140. The maintenance strategy development requires a business plan evaluation 142, an operational analysis of the plant 144, a criticality analysis 146, a motor identification 148 and a motor failure analysis 150. The maintenance strategy 140 is followed by defining motor maintenance plans 152. According to the

invention, the maintenance plan 152 development includes defining a hierarchical plant index 154, determination of key performance indicators 156 for the plant, the assignment of criticalities 158 for the motors, performance of a failure analysis 160, and assignment of maintenance actions 162.

The plan 152 is the foundation for the maintenance management 164 wherein standard jobs 166 are used for tasks due 168 on work orders 170 and requested work 172. The work orders 170 lead to a work schedule 178. From the management 164, the maintenance work 180 is performed by work groups 182 until the work is completed 184. The completed work feeds back into a work history 176. The work history 176 is provided for a motor register 174, which is a hierarchical plant structure of the company within which the standard jobs 166 are performed.

The maintenance management part 164 is subject to analysis and review 186 according to this invention. Historical data is reviewed, failure analysis is reviewed. A review is made of safety issues, employ statistical techniques to evaluation frequency of work and employ reliability engineering techniques to evaluate design out requirements. These can lead to an altering of the maintenance plan 188. For example, modification of the quality maintenance plan is done by failure analysis, review of maintenance actions, frequency of work, duration of work and by entering new motors. Alterations of the maintenance plan is part of the continuous improvement cycle.

Motor services according to the present invention is involved in a plant during much of the plant's history. For example, as shown in **Figure 5**, a plant is constructed at 198 and early on the motor services has only a small involvement as indicated at 200. Just prior to commissioning of the plant at 202, the sharp upswing in the motor services curve indicates increased involvement. After commissioning 202, the operation 204 of the plant provides a foundation on which is built the condition based inspection and preventative maintenance services 206 of the invention. Overlying the inspection and preventative maintenance services 206 is repairs 208 made to the

motors of the plant during its lifetime. These may fluctuate particularly under the processes of the prior art, but under the continuous servicing provided by the present invention, the repair involvement is steady. Over this is the modernization potential 210 realized by motor modernization projects. This leads to technical innovation as indicated by the increasing height of the line. The time line of involvement of the motor maintenance program ends at the decommissioning 212 of the plant.

As illustrated in **Figure 6**, through the application of the present invention, the business objectives of a customer 214 come into alignment 216 with the business objectives of the service provider 216 under the performance based contract 220.

Thus, the motor management program is a modular service package that tailors the maintenance improvements to the budget of the business and to the customer's business objectives. An important aspect is that the modular service package leaves the core competencies to the business. Benefits are provided including a reduced motor maintenance cost through pro-active business based maintenance, a minimized motor downtime, an optimized asset management including capital solutions and a fast response when and where the customer needs it.

In further detail, the modules offered under the basic services include a condition monitoring program 90. Using state of the art methods to assess the condition of the plant and the machinery such as thermography, vibration measurements, ultrasonic testing, partial discharge testing, oil and fluid analysis, and technical endoscopy, advanced warning of problems is provided.

An aspect of the present motor services is that emergency calls costs are covered by the agreement at no added expense to the customer under the emergency response module 92.

In undertaking the motor management program, the motor management review has been performed. This identifies improvement potentials so that measures can be derived from that review to improve the motor maintenance effectiveness, based on the implementation of a continuous improvement process. The goals are to provide

short-term recommendations focused on the development and implementation of a Maintenance Quality Improvement Plan and provide short-term recommendations focused on the development and implementation of a Maintenance Quality Improvement Plan.

An audit or review is performed using a standardized approach and objective assessment techniques. Categories for the audit include such as motor condition monitoring and predictive maintenance, motor repair procedures, motor reliability improvement, motor information management, etc.

An motor condition assessment 118 is provided. Assessment is made of information correctness, housekeeping, physical and mechanical condition, mounting and base condition, vibration levels and insulation. Both in-service motors and spare motors are evaluated. The Motor Condition Assessment is designed to provide a formal, structured and cost efficient way of assessing the physical, mechanical and electrical health of the plant's motors. Motors are reviewed at to determine if it is critical. Standardized tests and inspections are utilized and a numerical value is assigned for use in trending and comparison.

According to the invention, computerized maintenance solutions offer an efficient maintenance operation using computers to plan, schedule and record motor maintenance work. The computers run software for such tasks, which is also capable of handling materials management and spare parts logistics. The success of the computerized maintenance management system relies on activities such as design, selection, installation, population and staff training. Populating the software with the motor data from the planning phase requires a significant manpower effort. Under the present invention, this manpower effort is provided as a service to the customer in a combined maintenance and information technology function. In a preferred development, the provider has at hand intensive understandings of special motor applications and relevant industrial experience, and works hand-in-hand with the motor maintenance provider. One aspect of the computerized maintenance solution is

to deliver and implement interfaces to the enterprise resource planning system of the customer for purchasing an access control systems, materials and document management systems and condition monitoring systems.

As a result of these advances, the business strategy of the customer takes into account the ongoing changes resulting from globalization, technical advances and increasing competition. Best motor maintenance practices help reduce costs, increase plant availability, and improve product quality.

An additional basic module mentioned above is the inventory management services 84. The module offers the customer a physical count and identification, a motor inventory optimization analysis, and segregation and verification. The count and identification feature helps to identify recorded motor inventory, identify unrecorded motor inventory, collect nameplate data, and update the database. A visual inspection can also be performed as part of the inventory process. The motor inventory optimization and reduction 106 delivers to the customers the benefits of reduction in inventory investment and carrying costs, release of the value contained in the redundant inventory, a reduction of inventory maintenance and occupancy costs. It also releases the storage space occupied by the unneeded motor inventory for other uses. A positive cash flow results. A verification procedure is used to reduce risks of premature failure of required motor inventory. The segregation separates required from redundant motor inventory and permits the customer to verify that its required motor inventory is ready for active service duty. A benefit is that the customer may purge the redundant motor inventory.

Energy optimization 136 is implemented by a complete motor system review, which results in optimization recommendations with the objectives of motor energy savings and reducing variance in monthly energy costs.

A shared inventory module 112, as mentioned above, is based on the inventory review to identify potential motor inventory sharing partners. A facility consensus on common motor repair specifications and motor inventory levels. Excess motor

inventory can be liquidated. Storing, maintaining and managing of a shared mutual motor inventory is provided. The shared motor inventory benefits include reduced motor inventory investment and carrying costs, reduced storage, maintenance and occupancy costs. It releases the value in redundant motor inventory, effecting a positive cash flow. A reduction in the number of premature motor failures due to storage and maintenance practices is also realized. This also provides a forum to discuss other mutual sharing opportunities.

High-end modules in further detail include the following: A contract is prepared for agreement between the customer and provider. Task sheets or maintenance schedules are prepared outlining the scope of the work, and estimates of costs are prepared.

A commercially focused strategy is adopted and a performance-based relationship is established between the customer and provider by which the provider accepts some calculated risk. This is different than a time and materials maintenance agreement. In addition to accepting motor and materials costs, the provider may also accept risks at to labor costs.

The performance contracting option features tangible value-added evaluation systems, key performance indicators, a third party validation of motor asset review, and scheduled reviews. Risks are minimized while the provider and customer enter into a win/win relationship using a performance based fee, at least in part. This could depend not only on the maintenance performance but also on the market condition for the plant. Effectiveness is provided through measured criteria.

The high level option of full coverage 134 features asset review and motor replacement. This provides the customer with predictable costs, motor replacement including labor over the term of the contract, and reduced inventory. These high level options are focused on prevention, prediction, correction, inspection, and detection under the umbrella of business based maintenance.

The present invention is applicable to technical maintenance situations for a variety of businesses, including e-business (electronic business). On line ordering of parts or services is considered in this regard. The present invention is also particularly useful for B-to-B (business to business) companies.

As a feature of the performance based contract, a guarantee may be included to specify an up-time for the on-line service. For instance, the conditions of the contract may specify a 98 percent up time for the motor system being served by the present method.

A further high level option available to the customer is to offer financing 132 for motors that is being serviced under the present method.

Thus, the present invention offers customized outsourced motor services to a customer. These are related to the business strategy of the customer. The method of the present invention provides that the motor services provider becomes aware of the customer needs and then offers a modular service package tailored to the needs of the customer. Each solution for each customer is different. Different combinations of the modules are offered depending upon the customer's needs. This has a greater benefit for the customer.

Under the present invention, a business based maintenance is provided following a comprehensive approach with results oriented motor management. Business needs are identified and then a tailored packages of services are developed to meet defined objectives. An efficient partnership is formed between the customer and maintenance services provider, which is focused on a win/win outcome. The key performance indicators provide strength to performance based contracts by checking such things as availability, cost reductions, and safety. A shared profitability enhances the ownership of the customer and is a key strategy for management and employee success.

The objectives of the programs are to maximize motor and system reliability, optimize return on maintenance expenditures, reduce inventory investment, and

improve cost avoidance. Basic modules provide a base and are technology oriented and cover basic maintenance needs. Atop the basic modules are high-end options which take the customer to a business based maintenance solution tuned to the special needs of the business. The basic modules of the motor management program are designed to ensure that maintenance issues are detected and addressed at their earliest stages. This increases reliability as well as availability of motor systems. The result is that the bottom line dollars of the business will increase.

An aspect of the present invention is to provide a motor management program. The business strategy of the customer is taken into account in ongoing changes as a result of globalization, technical advances and increased competition. The motor management program is a part of the strategy to develop business based maintenance. A broad range of maintenance services are offered which are designed to provide comprehensive vendor- independent solutions. The benefits of the motor management program are increased motor reliability and availability, reduced costs through a pro-active business based maintenance approach, minimized down time, optimized asset management, capital solutions, and fast response when and where the customer needs it.

By offering the modular service packages, the motor management program tailors the maintenance improvements to the budget of the business and to the business objectives. Benefits are provided including a reduced cost through pro-active business based maintenance, a minimized motor downtime, an optimized asset management including capital solutions and a fast response when and where the customer needs it.

The business based maintenance is a process that defines the motor and maintenance needs in terms of the business goals of the customer. A uniquely tailored maintenance strategy has been developed to help the customer reach their objectives. Working with the maintenance organization, the providers engineers and maintenance specialists have assessed the current situation and developed strategies based on the



plants specific motor system requirements. By working closely with the employees of the company, sustained improvements are achieved which leads to success.

In one aspect of the invention, the provider of these services is a manufacturer of motors and is a maintenance services provider with know-how. Such a provider offering modular services according to the present invention can keep the motor system fully operational and the motors up to date. A significant feature of the present invention is that the services are vendor independent.

The objectives of the program are to maximize motor and system reliability, optimize return on maintenance expenditures, reduce inventory investment, and improve cost avoidance. Basic modules provide a base and are technology oriented and cover basic maintenance needs. The high end options take the customer to a business based maintenance solution tuned to the special needs of the business. The basic modules of the motor management program are designed to ensure that maintenance issues are detected and addressed at their earliest stages. This increases reliability as well as availability of the motor system. The result is that the bottom line dollars of the business will increase.

The best maintenance practice of the present invention puts the customer ahead of his competition allowing the customer to focus on his core business. Increased motor availability and reliability are provided, while aligning maintenance to the business strategy of the customer and reducing maintenance costs. Eliminating the cost of unplanned motor failures and optimizing asset management is also another advantage of the present invention.

Thus, customized motor maintenance services are provided for a business covering every type of motor irrespective of manufacturer or technology. Worldwide support facilitates success in the application of the present method.

#### INDUSTRIAL APPLICABILITY

The present invention has industrial applicability by providing motor maintenance services to industrial plants, for instance.

Although other modifications and changes may be suggested by those skilled in the art, it is the intention of the inventors to embody within the patent warranted hereon all changes and modifications as reasonably and properly come within the scope of their contribution to the art.